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Platelet Profile after Pediatric Heart Surgery

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Platelet Profile after Pediatric Heart Surgery

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ABSTRACT

Cardiopulmonary bypass (CPB) during heart surgery is a well-known cause of hematologic dysfunction in the postoperative period and has been linked to a higher incidence of bleeding and platelet disturbances. Little is however known concerning the postoperative platelet profile. The aim of our study was to analyze the platelet count evolution in a pediatric population before and until the 10th postoperative day after cardiac procedures and to relate this evolution with pre-, intra- and post-operative factors. We used a retrospective design to analyze the medical records of 68 patients admitted to our Pediatric Intensive Care Unit. 51.8% patients subjected to CPB developed thrombocytopenia postoperatively. In patients with CPB platelet count fell sharply on postoperative day 1 and continued falling until day 5, when it reached a nadir, steadily increasing from that day onwards. Postoperative thrombocytopenia was significantly related to intraoperative CPB ($p=0.001$), aorta cross-clamp ($p=0.003$) and surgery duration ($p<0.001$) as well as plasma transfusion ($p=0.023$). *Conclusion:* a steep decrease in platelet count is to be expected after surgery and until 5 days postoperatively, which might be of great value for physicians working with children in the postoperative period, helping them to assess the severity of platelet levels and to make appropriate clinical decisions.

KEYWORDS

Pediatric, Heart Surgery, Platelet, Cardiopulmonary Bypass

ABBREVIATIONS

CPB – cardiopulmonary bypass

PICU – pediatric intensive care unit

RACHS-1 – risk adjustment for congenital heart surgery

25 “WHAT IS KNOWN – WHAT IS KNEW”

26 Cardiopulmonary bypass (CPB) during heart surgery is a well-known cause of hematologic dysfunction
27 in the postoperative period and has been linked to a higher incidence of bleeding and platelet
28 disturbances.

29 We found out that in patients being submitted to heart surgery with cardiopulmonary bypass the platelet
30 count has a steep decrease in the 1st postoperative day, continuing to decrease until the 5th postoperative
31 day.

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INTRODUCTION

Congenital heart defects are the most common type of birth defects. A recent systematic review found the worldwide incidence of these defects to be 9.1/1000 live births and 8/1000 in Europe [1]. The advent of extracorporeal techniques such as cardiopulmonary bypass (CPB) largely improved the possibility for these defects to be surgically corrected but despite improving significantly the long-term prognosis of these children [2] it is still a major cause of hemostatic and inflammatory disturbances [3]. These are even more pronounced in the pediatric setting due to their immature hemostatic system, congenital heart disease, surgical complexity and reduced blood volume [2]. CPB has been linked to a steep decrease in coagulation factor levels and platelet counts [4, 5] and to a significant increase in the incidence of bleeding [2,3,6,7] and need for blood product transfusions [2,7-9].

Different studies have addressed platelet behaviour [10-13]. Nonetheless, contradictory results referring to platelet function during CPB have been observed during the pre- and intra-operative periods, with studies pointing to platelet hyporeactivity [13], others to an increase in platelet activity [10,12] and even others to variable responses, with some patients experiencing an increase while others suffer a decrease in platelet aggregability [11]. Regarding platelet count variations have also been reported during the same operative period and several studies described a steep decrease in platelet count immediately after CPB initiation [4,5,10-13], as high as 71% [4,13], remaining throughout the procedure.

Little is however known about these aspects during the postoperative period. Platelet function is not routinely assessed and therefore, routine retrospective data are difficult to acquire. On the other hand, platelet count can be easily recorded. Nevertheless, few studies comprising the postoperative period have been conducted [5,11,14]. A postoperative decrease in platelet count might have an infectious or hemorrhagic cause. Hence, information on platelet behaviour postoperatively could permit a better judgment on when a decrease in platelet count should or should not be expected and, consequently, to act accordingly.

Therefore, this study aimed to describe the platelet count and identify the incidence of thrombocytopenia, preoperatively and until the 10th postoperative day, and to explore possible relations with pre-, intra- and post-operative factors.

METHODS

This was a retrospective study approved by the Institutional Review Board who waived the need for parental informed consent.

Medical records of all children immediately admitted to a Pediatric Intensive Care Unit (PICU) of a tertiary hospital in Oporto, Portugal, after being submitted to a cardiac procedure for a congenital heart defect between January 1, 2013 to December 31, 2013 were selected and analyzed. Records from children aged <28 days were excluded from the study. The number of patients entering the PICU after heart surgery during the study period determined the sample size.

Data were collected from three different places. Patient's hospital records were used for preoperative data, anesthesia and perfusion flow sheets for intraoperative data and intensive care unit records for postoperative data.

Data on preoperative variables like age, gender, weight and main diagnosis were collected. Intraoperative data comprised type and duration of surgery, plasma, erythrocytes or platelets transfusion and, when applicable, the value of hypothermia, duration of CPB and aortic cross-clamp and Risk Adjustment for Congenital Heart Surgery (RACHS-1) score. Postoperative factors analyzed included PICU and hospital length of stay, the presence or absence of hypothermia, administration of heparin, furosemide, sympathomimetic amines or antibiotics and the need of dialysis or the transfusion of blood products.

Not only the platelet count for each postoperative day was analyzed as we also categorized this variable for the presence or not of thrombocytopenia, $<100\ 000/\text{mm}^3$ or $\geq 100\ 000/\text{mm}^3$, respectively. Thrombocytopenia was evaluated in each postoperative day and as its global occurrence in the postoperative period. Patients were also divided in two groups respective to the presence or absence of CPB during surgery.

Both thrombocytopenia and CPB were compared to pre-, intra- and post-operative variables. Mann-Whitney test was used for continuous parameters and categorical variables were analyzed with the Chi-Square and Fisher tests. A p value less than 0.05 was considered significant. Data processing and analyses were performed with SPSS 20.0 software (SPSS Inc, Chicago, IL).

99 RESULTS

100 During 2013 there were 91 entrances in the PICU after cardiac procedures. From these 3 patients
101 underwent a pacemaker-related intervention or pericardiocentesis, 7 had surgery for a heart transplant,
102 rheumatic or infectious diseases, 2 patients went to the Cardiothoracic Surgery Unit in the immediate
103 postoperative period due to an impossibility of chest closure, 1 patient died shortly after surgery and 10
104 medical records were unavailable and were therefore excluded. At the end 68 medical records were
105 analyzed with 56 (82,4%) with CPB. Patients' demographic and perioperative information is summarized
106 in Table 1.

107 When compared to patients submitted to surgery without CPB, those undergoing surgery with CPB
108 required more postoperative transfusions (39.3 vs 8.3%, $p=0.048$) and had a higher incidence of post-
109 surgery thrombocytopenia (51.8 vs 8.3%, $p=0.006$) (Table 2). Newly developed thrombocytopenia was
110 41% for all children and 49.9% for the CPB group. Postoperative complications as renal failure or
111 infection showed no relation to CPB procedure. No significant difference was found regarding
112 preoperative platelet values in both groups. However, after surgery, there was a steep decrease on platelet
113 count, significantly more pronounced in the CPB group, reaching a nadir on postoperative day 5,
114 increasing from that day onwards (Figure 1), which occurred irrespective of patients' age category (data
115 not shown).

116 From the 64 patients with preoperative platelets count, 2 (3.1%) had preoperative thrombocytopenia. On
117 the other hand, during the postoperative period 30 (44.1%) patients developed thrombocytopenia.
118 Postoperative thrombocytopenia was significantly correlated to intraoperative factors such as aorta cross-
119 clamp ($p=0.003$), CPB ($p=0.001$) and surgery duration ($p<0.001$), plasma transfusion ($p=0.023$) and
120 RACHS-1 score ($p=0.02$) and to postoperative parameters such as the need for induced hypothermia
121 ($p=0.004$), peritoneal dialysis ($p=0.034$), blood transfusion ($p<0.001$) and sympathomimetic amines
122 support ($p=0.009$) but not to infection ($p=0.088$) (Table 3). Thrombocytopenia was not significantly
123 related to patients' gender, age or weight. Nor CPB employment or postoperative thrombocytopenia had a
124 significant relation with PICU and hospital length of stay.

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DISCUSSION

Analyzing the platelet count after surgery we observed that for patients being submitted to CPB the median platelet count had a 49.4% decrease in the 1st postoperative day. On the contrary, those not being submitted to CPB had a 6.5% increase in the 1st postoperative day decreasing from that day onwards. The platelet profile followed a similar pattern on both groups, keeping significantly higher values in the non-CPB group. We found an incidence of newly developed thrombocytopenia of 41% globally and of 49.9% in the CPB group, similar to the value of 54.3% reported by others [14]. This decrease on platelet values might be due to hemodilution, contact activation of the hemostatic system or to the systemic inflammatory response after CPB [2,6] and has been observed in other studies [5,11,12].

CPB is a well-known cause of hemostatic dysfunction causing marked platelet disturbances during surgery [4,5,10,12,13] and increasing the postoperative risk for bleeding [2,8,11]. Ignjatovic V and colleagues [10] observed a marked decrease in platelet count accompanied by an increase in their activity during CPB procedures in children up to 6 years. Accordingly Ranucci M and associates [11] describe a diminution in platelet count until the 2nd postoperative day with variable platelet aggregability behaviour in patients until 4 years old. Karagöl B et al [14] went further on the postoperative period studying the platelet count until the 7th postoperative day, both in children with and without Down syndrome. They observed a marked decrease on platelet levels after surgery which persisted until the 3rd postoperative day starting to increase afterwards, albeit not reaching the preoperative values by the end of the study period. In our study patients undergoing CPB had a reduction of platelet values which persisted until 5 days after surgery, raising thereafter, still not reaching baseline values by the 10th postoperative day. However, late platelet values might be underestimated since analyses were only obtained for patients with a longer hospitalization period, which might comprise those with worst postoperative evolution with consequent lower platelet values. Additionally, patients not undergoing CPB had a sustained increase in platelet count after the 6th postoperative day and exceeded baseline values 8 days after surgery.

Postoperative thrombocytopenia showed a significant relation to other postoperative complications as the need for dialysis, transfusion, hypothermia and sympathomimetic support. It was also correlated to CPB, aortic cross-clamp and surgery duration and intraoperative plasma transfusion, which is in accordance to previous findings [14]. Although CPB procedure significantly correlated to post-surgery thrombocytopenia we found no such relation to the previously stated postoperative complications.

Some limitations of this study need to be acknowledged. First, we had to restrict platelet count information to days where analyses had been ordered instead of getting daily values and not every patient had the same hospital length of stay so, as days went by, fewer patients had analyses values which diminished the strength of the results. Nevertheless, we were able to obtain statistically significant differences between CPB procedure groups for most of postoperative days. Second, the reduced number of records analyzed with only 12 cases referring to non-CPB procedures caused statistically significant differences between both groups harder to achieve. Third, although postoperative thrombocytopenia has consistently been related to patient's age and weight [2,11], the limited number of our study population may have hampered this relationship.

We were only able to find one study addressing platelet evolution in the postoperative period and it was focused on children with Down syndrome [14]. Since thrombocytopenia is an important cause of morbidity during this period, information regarding platelet count profile may be of much value. Physicians working with children after heart surgery might find themselves uncertain of what to do in the presence of low platelet counts. Therefore, information on what is to be expected in this period may be very important to assess the severity of platelet levels and to make appropriate clinical decisions.

In conclusion, we found out that cardiac surgery seems to cause a marked decrease in platelet count, which is significantly more accentuated in the CPB group that is sustained over time and starts to increase only after the 5th postoperative day.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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TABLES AND FIGURES

Table 1 – Patient demographic and perioperative variables^a

Variable	Value	
Age (years)*	2 (1.1-7.8)	
Weight (kg)*	12.5 (8.6-22.5)	
Male gender [#]	39 (57.4)	
Operation time (min)*	279 (182-378)	
Surgery with CPB [#]	56 (82.4)	
CPB time (min)*	117 (57-172)	
Cross-clamp time (min)*	65 (34-96)	
Temperature, minimum °C*	34 (32-35)	
RACHS-1 score		
Undefined [#]	8 (11.8)	
1 [#]	16 (23.5)	
2 [#]	24 (35.3)	
3 [#]	17 (25)	
4 [#]	2 (2.9)	
5/6 [#]	0 (0)	

^a Values presented as median (interquartile range)* or number (percentage)#

Table 2 – Postoperative parameters from patients with and without intraoperative cardiopulmonary bypass (CPB)^a

Variable	CPB group (N=56)	Non-CPB group (N=12)	P value
PICU length of stay [*]	4 (3-7)	4 (4-7)	0.908
Hospital length of stay [*]	8 (7-14)	7 (6-9)	0.350
Postoperative use of			
Sympathomimetic amines [#]	28 (50)	3 (25)	0.115
Furosemide [#]	54 (96.4)	10 (83.3)	0.141
Antibiotics change [#]	12 (21.4)	2 (16.7)	1
Dyalisis [#]	4 (7.1)	0 (0)	1
Blood products transfusion [#]	22 (39.3)	1 (8.3)	0.048
Hypothermia [#]	14 (25.5)	0 (0)	0.058
Postoperative thrombocytopenia [#]	29 (51.8)	1 (8.3)	0.006

^aValues presented as median (interquartile range)* or number (percent of column population)#

261 Table 3 – Pre-, intra- and post-operative parameters from patients with and without postoperative
 262 thrombocytopenia^a

Variable	Nonthrombocytopenic cases (N=38)	Thrombocytopenic cases (N=30)	P value
Age (years) [*]	2.5 (1-8)	1.88 (1-7)	0.916
Weight (kg) [*]	14.8 (8-23)	12 (8.9-21)	0.961
Male gender [#]	22 (58)	17 (57)	0.919
Operation time (min) [*]	195 (157-279)	349 (286-449)	<0.001
Intraoperative plasma transfusion [#]	10 (31)	18 (60)	0.023
Intraoperative erythrocyte transfusion [#]	9 (28)	8 (27)	0.898
Intraoperative platelet transfusion [#]	12 (36)	16 (53)	0.176
Surgery with CPB	27 (71)	29 (97)	0.006
CPB time (min) [*]	76 (49-111)	156 (117-186)	0.001
Cross-clamp time (min) [*]	51 (22-70)	77 (62-116)	0.003
Temperature, minimum °C [*]	34 (0-35)	34 (32-34)	0.435
RACHS-1 score [#]			0.020
Undefined [#]	1 (3)	0 (0)	
1 [#]	12 (35)	4 (15)	
2 [#]	9 (27)	15 (58)	
3 [#]	12 (35)	5 (19)	
4 [#]	0 (0)	2 (8)	
5/6 [#]	0 (0)	0 (0)	
PICU length of stay [*]	4 (3-7)	5 (3-9)	0.081
Hospital length of stay [*]	7 (6-10)	8 (7-16)	0.414
Postoperative use of			
Sympathomimetic amines [#]	12 (32)	19 (63)	0.009
Furosemide [#]	34 (90)	30 (100)	0.124
Antibiotics change [#]	5 (13)	9 (30)	0.088

Dyalisis [#]	0 (0)	4 (13)	0.034
Blood products transfusion [#]	3 (8)	20 (67)	<0.001
Hypothermia [#]	3 (8)	11 (37)	0.004

^a Values presented as median (interquartile range)* or number (percent of column population)#

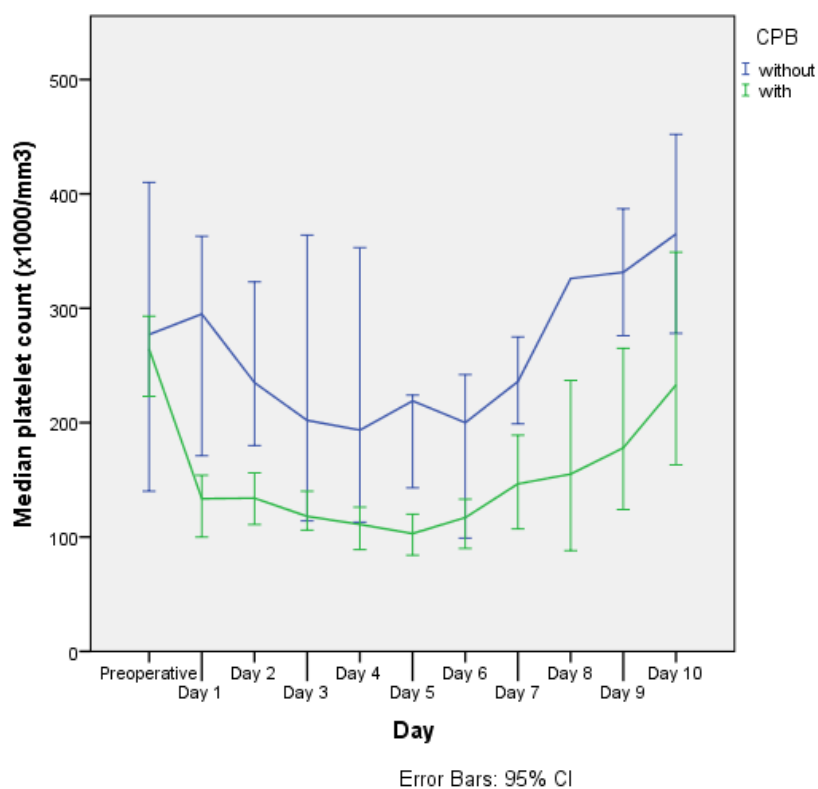


Figure 1 – Median platelet count preoperatively and during the postoperative period

Anexo – Normas da revista “European Journal of Pediatrics”

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References

Citation

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2. This result was later contradicted by Becker and Seligman [5].
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